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ABSTRACT

This booklet presents information about career opportunities for women in physics. Included are summaries of research areas in physics (optical physics, solid-state physics, materials science, nuclear physics, high-energy physics, astrophysics, cryogenics, plasma physics, biophysics, atmospheric physics) and differences between theory and experiment and between basic and applied research. Also included are discussions of job opportunities (focusing on those related to level of training), how to prepare for a career in physics, the current job situation, job discrimination, and marriage and a career. Brief profiles of 11 female physicists are also provided. (JN)

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The American Physical Society, comprised of 31,000 members, including 3,000 students, was organized in 1899 for "the advancement and diffusion of the knowledge of physics." The Society has traditionally fulfilled this objective primarily through the publication of the discipline's preeminent journals and through the organization of meetings.

The Society has been exploring new ways in which physicists can be of service such as the Congressional Scientist Fellowship Program, the Industrial Postdoctoral Fellowship Program, the Panel on Public Affairs, and the organization of studies on such topics as nuclear reactor safety and the efficient utilization of energy.

A number of standing committees have been established to consider on a continuing basis issues of concern and interest to APS members. Of these standing committees, it is the Committee on the Status of Women in Physics whose members have been responsible for the preparation of this booklet.

The Committee on the Status of Women in Physics was created by The American Physical Society to study the situation of women physicists and make recommendations based on this study. Members of the Committee have undertaken many projects bearing on the professional lives and concerns of women physicists and other women scientists. The Committee has planned and sponsored a variety of reports including salary and employment studies, career booklets, directories of women graduate students in physics, and a roster of women physicists, and in addition, has sponsored many symposia.

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WOMEN in physics

American Physical Society
Committee on the Status of Women in Physics

Have you ever wondered what is beyond space? Been curious about lasers or integrated circuits or atomic power? Perhaps physics is the place for you.

Physics is a science and science is an important part of today's world. Physics is concerned with the properties of matter, with electrons, protons, neutrons, atoms, nuclei, mesons, electric and magnetic fields, and seeks to find the laws that govern the behavior of all these things. Physicists are fascinated by the beauty and harmony of the physical universe and derive great satisfaction from learning and understanding its laws. Physics is the most fundamental science and underlies our understanding of nearly all areas of science and technology.

WOMEN IN PHYSICS

Many people think of physics as a man's field. Certainly most physicists in this country are men—97% of the Ph.D.'s and 93% of the B.S.'s in 1975 according to recent surveys. You may have heard that physics is too hard for women, too technical, too mechanical, too unfeminine. Of course this is nonsense!

Ideas about what men and women should do are changing now, and the fact that women have the abilities and can develop the skills to be successful in this fascinating and challenging field is becoming better known. Actually women have been successful in physics all along, in small numbers, often after resisting pressures to do something else instead. In fact the 1975 President of the American Physical Society was Dr. Chien Shiung Wu, an eminent woman physicist. Later in this booklet we will see how some women are handling careers as physicists today.

PHYSICS RESEARCH

The areas of physics research are far-ranging. The invention of the laser has added

tremendous excitement to the traditional area of *optical physics.* Lasers are used for making holographs, a new kind of photograph which produces a three-dimensional image. They are also used for microsurgery and as sources for spectroscopy, and show promise in communications and energy research. Recently, integrated optics, an analog of integrated electronics, has become a promising area of research.

Solid state physicists and *materials scientists* study crystals of metals, insulators, and semiconductors. Now there is much interest in amorphous semiconductors, liquid metals, and liquid crystals as well as superconductors, ferromagnets, and organic conductors. Many solid state physicists are interested in understanding the behavior of these materials,

Artist's conception of a black hole

Optical patterns in a liquid crystal

while others apply the results to produce many useful devices such as transistors, integrated circuits, and computer memories.

Nuclear physicists probe the complex world inside the atomic nucleus and their findings have led to useful developments such as nuclear power plants and controversial ones such as nuclear weapons. Maria Mayer shared the Nobel Prize in Physics in 1963 for her work on the shell model of the structure of the nucleus. Nuclear physics really began with research in radioactivity for which Marie Curie received two Nobel Prizes. Her life is described in a book written by her daughter (see bibliography).

High-energy physicists produce and study strange new particles—baryons, mesons, neutrinos, J particles—by accelerating the more familiar protons, neutrons, and electrons to tremendous energies to bombard targets, and detecting what comes out. In this way they study the most fundamental constituents of matter and the forces between them. High-energy experiments take place at large facilities and often involve large teams of physicists working together.

Astrophysicists use radio and x-ray telescopes to study distant galaxies and other sources of electromagnetic waves. A woman graduate student, Jocelyn Bell, recently discovered a flashing radio source called a pulsar, which might be a very small and dense star made up almost entirely of neutrons. Quasars, black holes, and other puzzling astronomical objects promise to excite interest for a long time. Like high-energy physicists, many astronomers make use of large research facilities.

Cryogenics is the study of the production of extremely low temperatures and the behavior of materials at these temperatures. At the other extreme, *plasma physicists* are attempting to produce thermonuclear power from plasmas of hydrogen or deuterium gas confined in magnetic fields at temperatures of millions of degrees Celsius.

Biophysicists apply techniques of physics to problems in biology, molecular biology, and biochemistry. The conduction of nervous impulses, processes occurring across membranes, and the structure of biological molecules such as DNA have been problems under active investigation by biophysicists.

The use of radioisotopes in the detection and treatment of cancer is just one example in the growing area of *medical physics*, the application of techniques developed in various areas of physics to problems of medicine.

Atmospheric physicists are concerned with weather patterns and construct sophisticated computer models of the atmosphere. They also study pollution control and other environmental problems.

Acoustics, chemical physics, atomic physics, oceanography, and geophysics are some of the other important areas of research activity by physicists.

THEORY VERSUS EXPERIMENT

Both theories and experiments are essential to physical research. A theory seeks to express in mathematical form a law governing the behavior of matter as observed in previous experiments. A new theory motivates new experiments to test it, and unexpected experimental results put theorists to work to explain them. Most research physicists specialize in either theory or experiment, although a few do both. Some theorists use pencil and paper, some use computers, while experimental equipment ranges from individual lab setups to giant installations requiring large teams of researchers. Sometimes theorists do "experiments" using large computers, for example, following the motion of a large number of "billiard balls" to study the motions of molecules in dense gases.

BASIC VERSUS APPLIED RESEARCH

Basic research is carried out to find answers to fundamental kinds of questions about, for example, how superconductors work or how elementary particles interact. Applied research takes the results of basic research and finds ways to use them to solve practical and human problems. Basic and applied research are closely related and depend very much on each other.

Most industrial research is applied and includes inventing and developing electronic devices, biomedical equipment, and new materials. Government laboratories sponsor applied research to meet national, social, and military needs. One important problem for the next several decades will be the production and conservation of sources of energy, and applied energy research will occupy many physicists in the fields of nuclear, solid state, and plasma physics working on breeder reactors, laser fusion, solar energy, geothermal energy, and environmentally acceptable ways of using coal. Another very important area of applied research will be medical physics.

JOBS IN PHYSICS

The level of the job you might have as a physicist will depend on your level of training, primarily as indicated by the college degrees you have earned. The most usual degrees for physicists to hold are the Associate in Science (A.S.), the Bachelor of Science (B.S.), the Master of Science (M.S.), and the Doctor of Philosophy (Ph.D.).

Physics research is carried out in research laboratories, at universities, and at government and industrial research laboratories. Large government laboratories—Brookhaven, Oak Ridge, Fermilab, Livermore, Argonne, Los Alamos, and Lincoln Labs—support both basic and applied research in many areas such as high-energy physics, nuclear physics, medical physics, energy research, and solid state physics. Industrial laboratories such as Bell Labs, Xerox, General Electric, Ford, Westinghouse, and IBM support applied and basic research in areas such as solid state physics, material science, optics, electronics, and communications.

Another important type of work that physicists do is teaching. There are many levels of physics teachers—high school, community college, junior college, four year college, and university.

With a bachelor's degree you can teach high school physics, although if you did this you would probably work on a master's degree part time. The special challenge of the high school physics teacher is explaining the concepts of physics to young people, beginners in science. Many high school physics teachers teach other subjects, mostly scientific, as well. With a master's degree you can teach at many community colleges and junior colleges, but an increasing number of four year colleges require the Ph.D. degree.

The small college offers teaching in a setting where there is intimate contact between

teacher and student. Colleges differ greatly in the size of departments and in the variety of courses offered. On some campuses independent research is encouraged and students often participate in special research projects. The main emphasis is, however, on quality teaching and the design of courses and laboratory experiments.

The university professor, who almost always has a Ph.D., combines research with teaching undergraduate and graduate students. Often her or his research is carried out with the help of one or more students—usually graduate students working for their Ph.D. degrees—who are being trained to do research. Also participating in university research are post-doctoral research fellows who have a Ph.D. and are gaining further training in research. An enjoyable and stimulating part of scientific research, whether in university or college or research laboratory, is attending scientific conferences in various parts of the country and the world, meeting other scientists, presenting papers, and exchanging ideas.

As a physicist you might also find yourself in an important and responsible job as an administrator such as a college dean, department head, or government official. Examples of women physicists with this kind of job are Elizabeth Baranger, who is Associate Dean of Arts and Sciences at the University of Pittsburgh, and Mildred Dresselhaus, who is Director of the Materials Science Center at M.I.T.

Opportunities exist for A.S., B.S., or M.S. degree holders, as computer programmers, technicians, and research assistants in university, government, and industrial laboratories. The computing industry hires many B.S. and M.S. degree holders. Frequently such people end up in jobs which, at first sight, seem to have little to do with their physics training, for example, science writing, science editing, industrial quality control, scien-

tific management, scientific equipment sales, and government service (e.g., in the Patent Office). In general, a first or second degree in physics is a good jumping-off point for any career which requires the ability to think clearly and logically and to attack and solve problems.

HOW TO PREPARE FOR A CAREER IN PHYSICS

In high school take all the mathematics you can. Math is very important for physics and other sciences as well. Some girls fail to take enough math in high school and then have difficulty with their science courses in college.

Insist upon taking shop and electronics. The time when the girls took home economics while the boys took shop should be over by now. Besides being fun, shop courses prepare you for possible work in experimental physics. Girls often don't get much experience with tools at home, so it is especially important to learn these skills in school.

Take science of course, particularly physics, chemistry, and biology. Many fields of current interest are interdisciplinary so you should get as broad a background as possible. Certainly take any available enriched courses in physics.

After high school you may choose to attend a junior college to earn an associate's degree. This training requires two years and prepares you for a job as a technician assisting and working under the supervision of research scientists (usually Ph.D.'s). Most people who earn the associate's degree do not plan to earn a more advanced degree

If you choose instead to earn a B.S. degree, you will attend a four year college or a university. In selecting a college or universi-

ty, talk to your guidance counselor, your high school physics teacher, and if possible, a physicist in your community. It is possible to find good physics departments both at colleges and at universities. Some students prefer the quieter and more intimate atmosphere of a small college while others prefer the stimulating atmosphere of a university where research and graduate education are going on.

Shop training is important for physicists

You will probably major in physics, although an engineering degree is also a good preparation for advanced work in physics (and vice versa). Most physics majors begin with a general physics course and then take intermediate and advanced courses in various

branches of physics—mechanics, electricity and magnetism, heat and thermodynamics, modern physics (atomic, nuclear, solid state), electronics, and often independent study. Your major advisor can be of great help in planning your program. Laboratory work is an important part of your physics education. As many girls may be somewhat lacking in mechanical background, you should take every opportunity to acquire skills in working with lab equipment.

In college you should continue to take as much mathematics as you can, chemistry, and biology (if you are interested in biophysics). Chemistry is very closely related to physics (there are physical chemists and chemical physicists) and is especially important for solid state physicists. Computer programming courses are also very helpful.

Foreign languages are useful—German, Russian, French—and it is important to learn to express yourself well in English. You can also broaden your education with humanities and social science courses. In general, keep your options open and don't specialize too soon.

There are opportunities for undergraduate science students to learn about research through summer programs sponsored by a number of government and industrial laboratories. Ask your advisor for information.

Toward the end of college you may decide to go on to graduate school in physics, or you may be interested in graduate work in another field such as education, engineering, or chemistry, or you may look for a job in physics or a related field. Seek advice from your advisor and other professors, but make sure they are advising on the basis of your abilities and not on the basis of some stereotyped idea of what women should do. If you are fascinated by physics and are doing well in it, by all means consider continuing.

The M.S. degree is usually earned in one to three years after the B.S.—depending mostly on whether or not you do a thesis project (an original study of a problem in your field of specialization). Some schools require a thesis project for a master's degree, some don't. Often a master's thesis is required only if you are not going on for the Ph.D.

It normally requires three to seven years after the B.S. to earn a Ph.D. You may or may not earn the M.S. along the way. It's good insurance to get the M.S. in case work toward a Ph.D. is interrupted for some reason. As a Ph.D. candidate in physics, you will be required to develop a deep understanding of the fundamental areas of physics and the ability to conduct independent scientific research. Your doctoral thesis project, chosen in collaboration with your thesis advisor, will be an original physics research project worthy of publication in scientific journals. Earning a Ph.D. in physics requires a great deal of hard work and time, but the rewards involved in conducting high level research more than compensate.

Most graduate students are able to obtain financial aid in the form of fellowships (which are an outright grant of money) or assistantships (which require part-time teaching of undergraduate laboratories, grading of papers, help with a faculty research project, or the like). Many good schools have financial aid available and are actively searching for good students.

THE JOB SITUATION

Frankly, at the present time it is difficult to find a permanent university job in physics or in almost any other field. In fact it is not easy to find any professional job right now and physics is no worse than most other disciplines. Some areas (high-energy physics for example) seem to be particularly tight. The competition is keen but the good people are finding work. Affirmative action is beginning

to make it somewhat easier for women to get fair consideration for jobs. There appear to be more jobs in industry in applied physics, especially experimental applied physics, so it is wise even for a theorist to get some experience in performing experiments. The area of energy research promises to open up jobs for physicists who will have the extra satisfaction of knowing that they are contributing to society's needs while doing work they enjoy.

There is reason to hope that the job picture will change by the time you obtain your physics degree. In any case, remember that your physics training gives you a good basic background from which you may go on to numerous jobs in many different fields besides just a specialized area of physics.

JOB DISCRIMINATION

There *has* been discrimination against women in the job market and it will probably continue for a while. But as more women enter the field, the barriers will come down. There are a number of reasons for the discrimination. In a male-dominated field, male physicists have not taken female physicists seriously enough. "Men have great difficulty perceiving brilliance in women," as Sheila Tobias, Associate Provost of Wesleyan University, puts it. And women have not taken *themselves* seriously enough. Sometimes insecure men feel threatened by competent women. Lack of mobility and child care responsibilities have hampered the advancement of women. However, younger women of today are finding themselves more easily accepted than did their predecessors. The requirement of affirmative action is helping to open jobs to women, although progress is much slower than it should be. Industry and universities are beginning to adopt more reasonable attitudes toward maternity leave and child care problems.

So things have never looked better for women, but you do have to be persistent and

assert yourself. If you don't believe in yourself, no one else will take you seriously. If you don't expect (and demand, if necessary) full professional respect, you may well get second-class treatment.

The following are comments women physicists have made about job discrimination. As you can see, their experiences and perceptions vary widely:

"Yes I think I have been discriminated against on a number of occasions, but I have also encountered a number of encouraging and supportive colleagues."

"I have not felt discriminated against as a woman physicist."

"I met with some people who were unwilling to believe I could be both a woman and a physicist, and for a while that bothered me but as my career progressed and I found myself happily married to a wonderful husband such doubters ceased to be other than laughable. I believe I have always found other physicists ready to accept me as they accept any other physicist on the basis of my work and ability in the field—the doubters tend to be men who think of physics as unintelligible and somewhat awesome."

"There is terrible discrimination against being a woman, still. I am the only woman in my department of twelve, receive a salary that is several thousand dollars less than the next."

MARRIAGE AND A CAREER

Women don't have to marry to be successful in life, but many do and find that marriage has many rewards. It can, however, pose problems for the professional woman. A husband who is unsympathetic to her goals and the demands of her profession will be a great barrier to her professional growth. Physics can be a demanding career and may require nontraditional lifestyles for married couples.

Today many young couples plan to share the responsibilities of housekeeping and raising a family, a change from the traditional family structure where women had the major share of such responsibilities. It is wise to come to an agreement about such things beforehand. Many couples nowadays are having fewer children or none at all—it is up to you. Household help is hard to find but many professional couples find it essential. Day-care centers can be a big help, and they are becoming more numerous.

Finding two jobs in the same area is often a problem. Sometimes one marriage partner has had to settle for the less prestigious job. Would you? Some couples these days are actually working in different cities. Again, these things can only be worked out between you and your husband and often call for ingenuity and faith in your abilities.

Some women wish to work part time when they have small children, while others prefer full time work with full time help. Working part time is preferable to not working at all when your family is young since it isn't wise to leave a rapidly moving field such as physics for very long. Many women who worked part time when their children were small have been unable to obtain full time professional employment later, although some have. A woman physicist who succeeded in finding a good full time job after working part time for several years says, "If I had to do it over, I would definitely work full time and make arrangements for a full time babysitter. By the time I realized that I would never get a 'real' job if I didn't get it soon, it was almost too late. The place where I had been working hired a man when they had a full time opening. I had to move with our children to a different town from where my husband worked in order to get a decent job."

There are a lot of old-fashioned ideas about marriage which are not too helpful for a woman physicist—or any career woman. Be-

sides the old notion about women's places being in the home, there is the idea that a woman shouldn't be smarter than her husband, or make more money, or be too successful or independent.

One woman physicist comments, "Some credit should go to my husband who is a strong supporter of the woman's movement. He encourages me in my work and career. We share the responsibilities at home equally." Another says, "It is not advisable for a woman physicist to take a maternity leave since physics is a field which moves and changes rapidly, and since one's productivity is greatest during the time when a woman would ordinarily want to start a family."

In order to give you some idea of "real life" careers for women in physics, we interviewed several women physicists. As you will see, many of them have solved very successfully the problems of combining a career and raising a family.

PROFILES OF WOMEN PHYSICISTS

Helen Quinn, an Associate Professor of Physics at Harvard University, works in theoretical particle physics ". . . trying to understand what are the fundamental components of matter and how they are held together. It is work which can be very exciting but also very frustrating—even both at the same time. It requires intense concentration but is often done in collaboration with other workers. One has long periods of discussion, and also long periods of sitting alone at one's desk trying to perform a calculation or find a new way to tackle a problem—or even just trying to choose a problem to tackle. I like both the interaction and the solitude. Since my job is in a University I also teach, which I enjoy doing. It gives me a very different kind of activity to my research, which is especially valuable in the periods when the research is progressing slowly.

Helen Quinn

"Working in a University has the advantage that I come and go as I please—my only firm time commitment being to meet my classes. This flexibility, and the fact that my husband has the same kind of flexibility in his working time has made it much easier to have two careers and children in the same family. We have also been very fortunate in having available an excellent day-care center, right where I work. I drop the children (now two and five years old) there in the mornings on my way to work, and collect them on my way home. My husband and I share equally in the work and fun of housekeeping and childraising—without such support from him having both career and children would be almost impossible. Research physics is a time-consuming occupation and so is raising children. That I do both means I have very little time left for other activities. My life is busy and full and interesting and I would not have it any other way."

Trudy Goldhaber is a senior physicist at Brookhaven National Laboratory, where basic research is emphasized. Her particular interest is in models of the behavior of protons and neutrons in atomic nuclei. She works

these models out from her own experiments and those of other physicists doing nuclear spectroscopy, using only those principles of nuclear theory which have been established beyond reasonable doubt. Nuclear spectroscopy may involve excitation of nuclei by particle bombardment and examination of the emitted γ rays, in much the same way as the spectral lines from atoms and molecules are analyzed to study their structure. Recently she has collaborated with one of her two sons, both high-energy theorists, in trying to understand the peculiar collective motions occurring in atomic nuclei which appear to be a combination of rotation and vibration.

From an early age Trudy Goldhaber delighted in handling numbers and her school courses in mathematics, physics, and chemistry so interested her that she went on to earn her Ph.D. in physics. Her parents did not encourage her in this direction, and in fact advised against it. She discovered that the problems in physics were more challenging to her than those in mathematics. There were diffi-

cult years while she was getting established, when she could not get a paid position at the University of Illinois where her husband taught because of a nepotism rule (which forbids employment of both husband and wife). "But I could have an office and graduate students. Although it was economically very difficult, I made use of this opportunity for a number of years in which I started to build up a reputation in my field—until I finally received an assistant professorship, in spite of the nepotism rule, because of an outside offer." The nepotism rule is now forbidden by law and talented young women can usual-

Pat Cladis (right) helps physics major prepare a liquid crystal sample

ly find positions, although not always in the most desirable environment. "The main thing is not to become discouraged and to keep one's eyes and ears open for opportunities."

Drs. Chien Shiung Wu and Gertrude Scharff-Goldhaber are so far the only physicists among the small number of women who are members of the National Academy of Science.

Pat Cladis is a staff physicist at Bell Laboratories and works on liquid crystals. These are systems whose order is partway between liquids and solids. They are composed of large organic molecules which are oriented in certain ways but neither in a fixed structure such as in a crystal nor at random as in a liquid. These materials have fascinating optical properties—you may have seen them used in displays, for example, in digital watches.

Pat did not start out in this field. She did her Ph.D. thesis at Rochester on superconductivity, and went to Orsay, France, to do postdoctoral research with an outstanding physicist. She expected to continue her work on superconductivity, but he was just starting a group on liquid crystal research and she became involved in this new field.

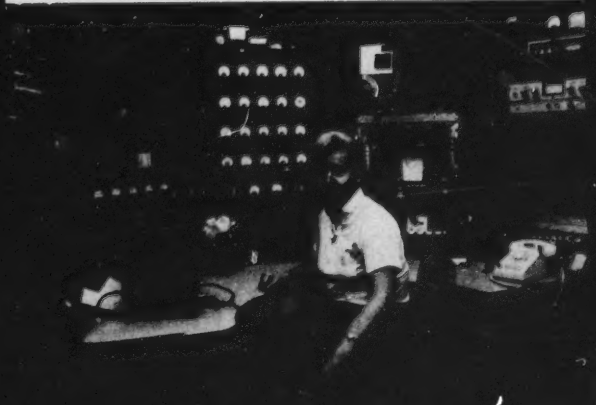
While in France her artist husband opened a studio in Paris, and their twin children benefited from the very good French child care facilities—the crêche day-care system plus school beginning at age two. They currently have a live-in housekeeper in New Jersey.

Kristen Johnson has a B.S. degree in Physics and Chemistry and works as a research assistant at the Cyclotron Laboratory at Harvard University. "The work we do at the Harvard Cyclotron is primarily directed toward the treatment of cancerous and noncancerous tumors by means of a proton particle beam. We have also been able to obtain pho-

tographs (similar to x rays) of various human organs and tissues utilizing this proton beam. In order to correlate what we see in the photographs with tissue density values (on which the absorption of the proton beam is largely dependent), much of my work has centered around experiments to determine these tissue density values."

Kristen feels that "being a woman in an essentially male occupation has not proved at all difficult." She finds that her work allows her much freedom and independence. She is a licensed amateur radio operator and enjoys communicating with people throughout the world in her spare time.

Janet Benton has a Bachelor's degree in physics and works as a senior technical associate at Bell Laboratories. She assists in experimental work on radiation-produced defects and impurities in silicon and other semiconductor materials. The way transistors and light-emitting diodes work depends crucially on just what defects are present in them, and her group does electrical measurements to



Kristen Johnson operating the cyclotron

Janet Benton

study how defects and impurities capture electrons and how those impurities diffuse. Although she has always been interested in science, Janet has only recently started working, having spent a number of years at home with a family. She finds that her background was somewhat theoretical and has had some learning to do about laboratory equipment. "I have to start from the beginning with each new instrument." But she enjoys the variety of the work and the feeling that she is contributing to something important.

Marjorie Meinel was an active astronomer, in collaboration with her husband, for a number of years. In recent years they have been working on solar energy utilization at the Optical Sciences Center of the University of Arizona. With a Master's degree in astronomy, she has found it possible to maintain a very active career in partnership with her husband while raising seven children.

"Science came 'naturally' to me. My parents were astronomers—mother was the first woman awarded a Ph.D. from the University of Chicago (1917), and father was at Mt. Wilson and Palomar Observatory for 40 years. I always looked up to the stars! Friends would ask, 'But what *use* is astronomy?' and I could not answer. I only knew it was for me."

Marjorie Meinel with compressed tumbleweed "log" and photovoltaic concentrator module

She married a man, also interested in astronomy, who went on to become director of Kitt Peak Observatory, and later director of the Optical Sciences Center of the University of Arizona. From their home, she collaborated with him and they are coauthors of a number of papers. She eventually became a Research Associate at the university.

"We spent some time in India establishing an observatory. It was while visiting missionary friends at a leprosarium in Nepal that we apprehended the misery of the masses in a low-energy low-technology society. Realizing the limits to our cheap fossil fuels, which have set us free from a dispassionate environment, we entered the field of solar energy to seek there a solution. And so here we are in a very practical field of science!"

A very interesting account of the Meinels' work in solar energy utilization is given in the February 1972 issue of *Physics Today.*

Esther Conwell is a Principal Scientist (with a Ph.D.) in the Xerox Research Laboratories,

doing research in basic and applied physics.

"A good deal of my work has been in solid state physics. Recently I have also been working in a new area of optics called integrated optics. The work is interesting to me because there is always something new to study, to learn, to discover. Also there are many opportunities to travel—to visit other laboratories or universities to give talks, to go to conferences—and to meet people. In addition, I find it interesting to work on something that may turn out to be useful—whether in a communications system or a Xerox machine, etc.

"The main disadvantage I have found in being a woman was that I did not have the range of job opportunities available to the men of comparable ability who got their degrees when I did. Once I got into a job and it was discovered I was competent I experienced very little discrimination. My salary was comparable to those of men with similar qualifications, making similar contributions. I became a manager of a small group, all men, mostly Ph.D's, enjoyed it and had the full cooperation and friendship of the men.

Esther Conwell and colleagues

Julia Wan

"If you are willing to work hard there is no reason why you cannot coordinate a career with marriage and/or children. It does not require that you be a superwoman. It is important that you make a good long-term arrangement for care of young children, such as a relative or a housekeeper who will stay with you.

"The special advice I would offer to young women is to choose their husbands carefully. It will be very difficult to have a professional career if your husband is not willing to take over, children and all, when you have to go off to a conference hundreds or thousands of miles away, to give or hear a paper. He can't just accept a job that he prefers in another city, but must consider your job opportunities as well as his. Ideally, a joint decision must be made on the basis of which move is best professionally for the two of you."

Julia Wan is Director of Science of Watertown Public Schools in Massachusetts. Her overall responsibility is the supervision of the science program for grades kindergarten to twelve. Her duties include science curriculum development and evaluation, planning and preparation of the science budget, supervision of science teachers which involves observing classes and making suggestions for

Dinah Moché and students

improvement, and planning in-service courses and workshops in elementary science.

"There are twelve schools in Watertown, eight elementary schools and four secondary schools. The broad responsibilities and the variety of duties of the position offer many interesting and challenging experiences. I can say that I never had a dull day. I am still learning something new every day."

Jui[illegible] has a B.S. in physics and a master's degree in chemistry and is working on a doctorate in Educational Administration and Supervision. She offers three items of advice to young women wanting to enter the scientific field. "1. It is very important to have *long-term* career goals. 2. Do not let traditional sex-stereotyped pressures bother you. 3. Be persistent."

Dinah Moché has a Ph.D. degree in physics and teaches astronomy and physics at a community college.

"Community college teaching is interesting because I have students from ages 16 to 70, all with varied life experiences that enrich my own. In order to keep them interested in my classes I have to keep learning new things all the time.

"If anything is to be learned from my life experiences so far, it is that a young woman should keep as many doors open to herself as possible. Take all kinds of subjects in junior high and high school, so that she may take advantage of any opportunities that occur.

"Because I had enough high school math preparation, I was able to start physics in college. I married in college at the beginning of my sophomore year, completed my B.A. in physics in three years, and followed my husband to his job as was customary then. I went to graduate school and after my first child was born completed the M.A. and looked for part-time work compatible with child-rearing. So began my teaching career. Over the years I kept taking courses and NSF Institutes. This year I completed the Ph.D. Widowed at 30 with two young children, I was very happy to have a full time teaching job at a community college—I could still somehow take care of the children while supporting us. When I subsequently remarried a widower with two small children, I continued to work. My work is interesting, provides necessary income, and allows me time for family life.

Kathy Levin and colleague

"Being a woman has influenced me every step of the way, because I have always put my children's and husband's welfare first when making decisive career choices as I was raised to do. If I could change things, I would complete my own education before getting married!"

Dinah has recently completed a project, sponsored by the National Science Foundation, to produce multimedia packets containing audio cassette interviews, slides, and written material on Women in Science, available from the American Association of Physics Teachers (see bibliography). She has written several very popular books for young people and adults on physics and astronomy.

Kathy Levin grew up around scientists—her father is an experimental physicist—and since she excelled in physics, chemistry, and mathematics in high school and college, she was encouraged to go on and get her Ph.D. from Harvard. She is now an assistant professor at the University of Chicago. "I am a solid state theorist. My work involves doing research, teaching, and supervising graduate students. I have a wide range of interests within solid state theory: magnetism, superconductivity, disordered systems (alloys), and surfaces. I particularly like solid state physics because I can work closely with experimentalists. I prefer to think about problems which are related to experiments, rather than problems which are of a purely formal or mathematical nature. The exotic phenomena (e.g., superconductivity) which are associated with phase transitions are particularly interesting to me."

Kathy is married and just beginning a family and feels that "a woman who has a career and family has a large number of responsibilities and will encounter many more difficulties than one who has only a career or only a family. It is important to have an extremely cooperative husband and good household

Vera Kistiakowsky

help. Being married to a professional man will involve a large number of compromises on both sides, and finding positions which are suitable for both members of the couple is often extremely difficult. With both a career and a family, one has very little spare time to indulge in other activities or hobbies. However, the richness and excitement of having both more than compensates for the disadvantages."

Vera Kistiakowsky is a high-energy experimentalist and a professor at M.I.T. Her current experimental work involves scattering of pions by protons and is carried out at Fermi National Accelerator Laboratory. She also teaches, and is active in the American Physical Society where she is on the Council and several committees. Vera founded and was the first chairperson of the APS Committee on The Status of Women in Physics, and has a strong interest in the special problems of women in science.

Vera finds her work fascinating but says that high-energy physics is a very competitive field, and very expensive, and has been hit badly by government budget cuts so that currently there are a very few jobs.

"Other scientific fields are currently suffering from similar problems to a greater or lesser degree and the times when a Ph.D. guaranteed a good job are now over. However, anyone with a strong interest in science will not and should not let this stop them.

"I think that the problems that I had with career vs marriage and motherhood were due to the view of the woman's role prevalent in my generation. A young woman today even if she is not a feminist would have a much more liberated viewpoint. And so do many young men, making parenthood as a cooperative venture possible."

Vera is the author of two children's books on science, and when not doing physics she has time to ride and ski with her two teenage children.

For further reading, etc.:

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This booklet was written by Laura M. Roth and Nancy M. O'Fallon. Laura Roth is a professor at SUNY Albany and is a theoretical solid state physicist. Nancy O'Fallon has a background in nuclear physics and is doing energy research at Argonne National Laboratory.

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